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Robotic Retroperitoneal Partial Nephrectomy: A Four-Arm Approach

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ABSTRACT

Introduction: Robotic partial nephrectomy is an effective alternative to laparoscopic partial nephrectomy. The 3-arm and 4-arm transperitoneal robotic approaches are well described in the literature. However, a retroperitoneal robotic technique has yet to be fully described. We report our technique and initial experience with robotic retroperitoneal partial nephrectomy with a novel 4-arm approach.

Materials and Methods: We reviewed our current experience with the robotic retroperitoneal approach. Descriptive statistics on patient characteristics, operative parameters, and oncologic outcomes are reported.

Results: A total of 67 robotic-assisted partial nephrectomies were performed by one surgeon between October 2009 and October 2010. The 4-arm retroperitoneal approach was used in 8 patients (12%) with no complications. Median tumor size was 2cm. All were posterior renal tumors, with 5 located in the upper pole. The median operative time, warm ischemia time, estimated blood loss, and length of stay were 202 minutes, 18 minutes, 100cc, and 2 days, respectively. Pathology indicated renal cell carcinoma (RCC) in 7 patients with negative margins.

Conclusion: The 4-arm robotic approach to retroperitoneal partial nephrectomy is safe, reproducible, and easily used. The fourth arm provides optimal traction on target tissues in key maneuvers and may decrease complications and positive margins secondary to impaired exposure.

Key Words: Robotics, Nephrectomy, Renal cell carcinoma, Retroperitoneum.

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Joseph Feliciano has no competing financial interests. Michael Stifelman is a speaker for Intuitive Surgical, Inc. and for Baxter, and a consultant to Vascular Technology Inc. and Philadelphia Urology Associates.

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INTRODUCTION

Open partial nephrectomy (OPN) has been the gold standard in treating renal masses amenable to nephron-sparing surgery. Recently, laparoscopic partial nephrectomy (LPN) has been shown to have equivalent oncological outcomes to OPN with 7-year metastases-free survival of ~97%.[1] Laparoscopy has many proven advantages, such as a shorter convalescence period, shorter hospital stay, and less postoperative pain. However, straight LPN requires highly advanced laparoscopic skills during critical portions of tumor excision and renorrhaphy and remains technically challenging, therefore limiting its widespread utilization. Robotics may make this minimally invasive procedure more accessible to urologists with prior robotic prostatectomy skills. In addition, it has been demonstrated that surgeons with advanced laparoscopic skills improve their outcomes including decreased warm ischemia time, blood loss, and length of stay when using robotics.[2]

As with standard laparoscopic techniques, robotic partial nephrectomy (RPN) can be done through a transperitoneal or retroperitoneal approach, each with its own advantages. The 3-arm and 4-arm transperitoneal RPN techniques are well described in the literature.[3,4] However, a retroperitoneal robotic technique has yet to be fully described. We report our technique and initial experience with robotic retroperitoneal partial nephrectomy with a novel 4-arm approach.

METHODS

A retrospective review was performed on our prospectively maintained IRB approved Renal Tumor database on all RPNs performed by single surgeon (MS) from October 2009 to October 2010. Included in this study are 8 patients for whom we used the 4-arm retroperitoneal approach, which was chosen because of the posterior location of the patient's tumors. Descriptive statistics were performed for patient characteristics, operative details, and pathologic outcomes.

Surgical Technique

All patients underwent appropriate medical optimization prior to surgery.

After general endotracheal anesthesia is administered, the patient is placed in the full flank position. The body is flexed to expand the distance between iliac crest and the tip of the 12th rib. A 12-mm camera port is placed in the midaxillary line midway between the costal margin and the iliac crest. The retroperitoneum is entered under vision, and a balloon dilator is used to create the retroperitoneal space. A 30-degree up endoscope is used initially to aid trocar placement. The 8-mm robotic ports are placed under direct endoscopic visualization using our novel configuration **(Figure 1)**. The lateral and medial robotic trocars are placed in the posterior axillary line and anterior axillary plane respectively parallel to the camera-port trocar. Prior to placing the fourth arm, the peritoneum is swept medially towards the paramedian plane. Then under direct visualization, the fourth arm trocar is placed in the most medial and inferior aspect of the field approximately 7cm to 8cm across and 2cm below the medial robotic trocar avoiding the peritoneal edge. A 12-mm assistant port is placed between the camera port and medial dissecting arm port. The da Vinci robot is then docked over the patient's head and shoulders. We then use a 0-degree robotic lens for the remaining portions of the case. We routinely use the Endowrist PK-dissecting forceps (Gyrus ACMI, Southborough, MA) and monopolar curved scissors for blunt and sharp dissection in the left arm and right arm, respectively. A ProGrasp forceps (Intuitive Surgical, Sunnyvale, CA) is used in the fourth arm port.

The first step is to develop a plane between the psoas muscle and Gerota's fascia posteriorly from the upper pole of the kidney to the lower pole. The goal of this step is to allow the kidney to be reflected medially. The ureter can be readily identified anterior to the psoas and followed towards the hilum. Once identified, the hilum can be placed on stretch and traction fixed by using the fourth arm to apply medial and anterior traction on the kidney. This maneuver allows the surgeon to have both left and right robotic arms free to dissect the hilum. We often use the aid of a laparoscopic Doppler probe to verify hilar position. Both renal artery and vein are then skeletonized to allow for adequate closing pressure during cross clamping with bulldog clamps.

The tumor location is then verified using a laparoscopic ultrasound probe (BK Medical, Peabody, MA). During this step, the fourth arm can be deployed to facilitate the exposure to the target area. The capsular borders of the tumor are defatted circumferentially to obtain a 1-cm uninvolved edge. The fat directly overlying the tumor is left attached to the capsule. Mannitol IV (12.5 grams) is then infused at this time in preparation for cross clamping. The tumor edges are then verified with the laparoscopic ultrasound and resection margins scored with electrocautery. The renal vessels are then clamped, and the tumor and overlying fat are excised sharply en-bloc in a circumferential manner. The fourth arm can again be deployed to stabilize the target area for excision.

Hemostasis is achieved prior to renorrhaphy. All visible large open vessels are suture ligated in an interrupted figure-of-8 fashion with 3-0 Vicryl (Ethicon Inc) sutures on an RB-1 needle cut to 15-cm length. Violations to the

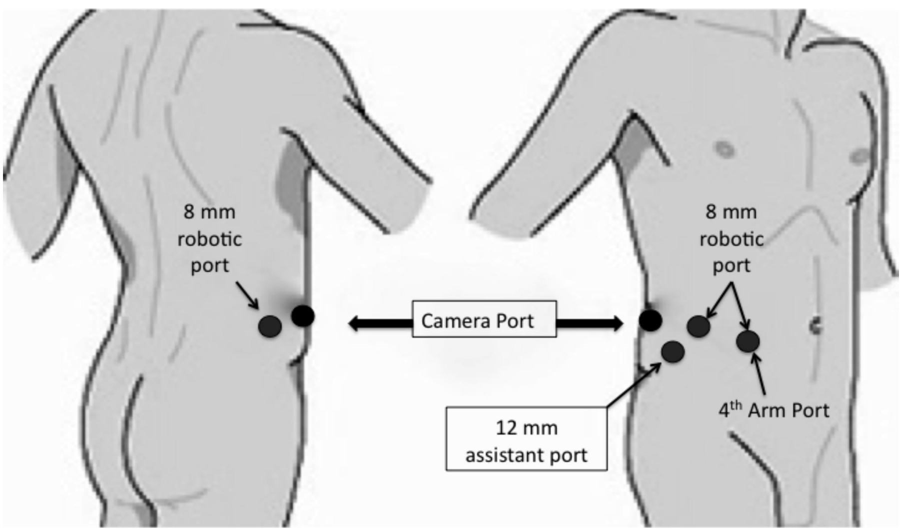

Figure 1. Trocar positions for robotic assisted retroperitoneal partial nephrectomy (right side depicted).

collecting system are also closed with 3-0 Vicryl sutures in an interrupted or running fashion. The resection base and any small capillary vessels are cauterized using monopolar energy with the TissueLink device (Tissue Link Medical, Portsmouth, NH). FloSeal is then applied to the parenchymal defect. Renorrhaphy is completed by placing several interrupted buttress sutures across the cut parenchymal edges. We used 2-0 barbed stitches (V-loc, Covidien, Mansfield, MA) with Weck clips (Hem-O-lok, Teleflex Medical, Durham, NC) on the ends on these buttress sutures, because the self-locking mechanism intrinsic to the stitch allows tension to be fixed and prevents the renal defect from unraveling. Once the desired tension is established on all buttress sutures, the proximal ends are then secured using the sliding clip technique. Renal blood flow is then re-established by first unclamping the renal vein followed by the renal artery.

The specimen is then bagged and recovered at the end of the case through the camera-port incision. A Jackson Pratt drain is placed through the medial robotic port and secured to the skin.

RESULTS

A total of 67 robotic-assisted partial nephrectomies were performed by one surgeon between October 2009 and October 2010. The 4-arm retroperitoneal approach was used in 8 patients (12%). Patient characteristics, operative details, and pathological outcomes are summarized in **Table 1**. Median age was 60 years with 5 having right-sided tumors and 3 having left-sided tumors. Median tumor size was 2cm. All were posterior renal tumors, with 5 located in the upper pole. The median operative time, warm ischemia time, estimated blood loss, and length of stay were 202 minutes, 18 minutes, 100cc, and 2 days, respectively. There were no intraoperative or postoperative complications. Pathology revealed pT1a renal cell carcinoma in 7 patients, and all had negative margins.

Table 1.
Patient Characteristics, Operative Details, and Pathology

Patient Total (n)	8
Median Age (yr)	60 (38–77)
Sex (n)	
Male	7
Female	1
Side of Involvement (n)	
Right	5
Left	3
Tumor Location	
Posterior upper pole	5
Posterior lower pole	3
Median Tumor Size (cm)	2 (1.5–2.5)
Median Operative Time (min)	202 (155–270)
Median Warm Ischemia Time (min)	18 (12–37)
Median Estimated blood loss (mL)	100 (50–350)
Median length of stay (days)	2 (2–3)
Pathology	
pT1aNxMx RCC	7
Positive Margins	0
Angiomyolipoma	1

DISCUSSION

Recent literature has shown that pathologic and functional outcomes with RPN are comparable to those of OPN and LPN.[5] Because straight LPN remains technically challenging, RPN has emerged as an attractive hybrid option for surgeons ready to adopt minimally invasive techniques and surgeons with advanced laparoscopic skills.[2,6]

RPN can be done safely and effectively through a transperitoneal approach.[3,5,7] This approach offers surgeons a greater working space with familiar anatomy but requires bowel mobilization thus possibly increasing the risk of ileus postoperatively. Like its straight laparoscopic counterpart, the transperitoneal approach may be best suited for anterior and medially located renal tumors, while a retroperitoneal approach may be ideal for posterior renal tumors.[8]

Several studies[8,9] have highlighted the benefits of a retroperitoneal approach in LPN including (1) prompt, direct access to the renal hilum and (2) confinement of surgical intervention products (blood and urine) within the retroperitoneum, minimizing the potential for postoperative ileus. However, the limited working space with this approach is a clear disadvantage with straight laparoscopic instruments. We have not found this to be an issue with the da Vinci platform given its articulating robotic instruments.

To date, this is the first report to detail a robotic retroperitoneal approach to partial nephrectomy utilizing 4-arm technology. As in the transperitoneal approach, the fourth arm can be deployed to provide fixed traction on several key maneuvers including hilar dissection, tumor excision, and renorrhaphy. Thus far, operative times, warm ischemia times, and EBL in our initial experience with the

4-arm retroperitoneal approach are comparable to that in published series of RPN using the transperitoneal approach.[2,5,10,11] More importantly, there were no complications, and all patients with renal cell carcinoma (n=7) had negative margins.

We acknowledge that there are limitations to our study. There is an inherent selection bias, because we specifically chose only patients with renal tumors located posteriorly for the retroperitoneal approach. Our patients also had relatively small tumors (mean 2cm) with pT1a disease on final pathology. However, given the promising results in this small cohort of patients, we confidently believe that the benefits of the retroperitoneal 4-arm technique can be extended to larger posterior renal masses amenable to nephron-sparing surgery.

The 4-arm robotic approach to retroperitoneal laparoscopic partial nephrectomy is safe, reproducible, and easily used. The fourth arm optimizes traction on target tissues and allows traction to be fixed in key maneuvers, such as hilar dissection, tumor excision and renorrhaphy. This is imperative in minimizing complications and positive margins secondary to impaired exposure and visualization.

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